[11] 11 전 12 전 12 전 12 전 12 전 12 전 12 전 1			
			STAT
· ·			:
	PERMAFROST		
	(Bol'shaya sovetskaya entsiklopediy Vol. 7, pp. 604-606.)	ra, 2nd edition,	
	,		STAT
			SIAI
			: : : : :
100 PM			
		•	
F563		The second secon	

STAT

## PERMAFROS T

Permafrost is a natural phenomenon characterized by the cooling of soil to below zero degrees Centigrade on the surface of the earth. This condition lasts uninterruptedly for from several years to several thousands of years, and changes along with changes in the physical-geographical surroundings. Water in solidified soils is found primarily in the solid state, but certain quantities of the liquid phase and of vapors exist in addition to the ice. The term "vechnaya merzlota" for "permafrost" is domestic, and was introduced into the literature in the middle of the 19th century.

The permafrost layer is covered over with a layer which thaws each summer, and freezes again each winter to a depth which varies in different geographic regions. This layer is called the active layer, since in it the freezing and thawing of soils is accompanied by a number of physical-mechanical processes, and in addition the life activity of animal and plant organisms also proceeds in this layer. Outside the permafrost region this surface layer is called the layer of seasonal or of winter freezing, or seasonal frost (sezonnaya merzlota, q.v.). Over a large part of the area of permafrost distribution the active layer comes together each winter with the permafrost soil layer. In regions where the upper extent of the permafrost layer is very deep these two frozen layers do not join, and a thawed layer remains between them, called a "talik".

The earliest information on permafrost in the literature dates from the end of the 16th and the beginning of the 17th centuries. In 1640-43 the governors of Yakutsk wrote to Moscow that "the earth does not thaw completely, even in the middle of summer" in that region. The first scientific investigations of permafrost were carried out in the first half of the 18th century on the Yenisey River, at the mouth of the Lena River, and in other localities in Siberia, in connection with the discovery of fossil mammoths. Of great significance was the expedition of the Russian Academy of Sciences under the leadership of Academician Middendorf, 1843-46. The expedition collected factual material on freezing in various places in Siberia, and the first data were obtained on the temperature of the permafrost layer down to a great depth (116 meters). This made it possible to calculate the full thickness of the permafrost layer for the Yakutsk area. At the end of the 19th and the beginning of the 20th centuries investigations were carried on primarlly in the southern protion of the region of permafrost distribution in regions which were beginning to be taken over for industrial and agricultural activity, in addition to the northern coast of Siberia and the islands of the Arctic Ocean, in connection with the recent discoveries of fossil animals.

In other regions few large investigations of permafrost were conducted. An exception was the work of Leffingwell in investigating the northern coast of Alaska.

There was a sharpbreak in the study of permafrost after the Great October Socialist Revolution. Planned, systematic studies of permafrost were begun for the first time in the USSR. An important

role was played by the investigations of M. I. Sumgin, which were published in his book <u>Vechnaya merzlota pochvy v predelakh SSR</u> (Soil Permafrost within the USSR), in 1927.

Permafrost is widely distributed throughout the world. The area which it covers totals about 20 to 25 percent of all dry land. In the northern hemisphere permafrost is distributed uninterruptedly within the Arctic Circle, and extends far to the south from the Circle toward the areas of the continents of Asia; North America (see map). In the southern hemisphere permafrost completely dominates the continent of Antarctica and the islands near the southern tip of South America. Separate regions of permafrost are located in mountainous regions of the medium latitudes of the northern and southern hemispheres, with the exception of Australia. Knowledge of permafrost is not sufficient. The limits of its distribution must be established more precisely. The regions of the distribution and the temperature zones of permafrost in the territory of the USSR are shown on M.I. Sumgin's map (see map).

The thickness of the permafrost layer differs in various regions. Proceeding from the southern edge of its distribution toward the north one observes a regular increase of permafrost. In a number of places in the northern regions the permafrost layer isseveral hundred meters thick; proceeding toward the south the layer of frozen earth grows steadily smaller, and finally dissappears.

The temperature conditions of the permafrost layer is to a

great extent dependent in each region on the climatic conditions of the present day as well as of the past. A close relationship is observed between the temperature conditions of the active layer and those of the upper part of the permafrost layer which lies underneath: through the active layer the heat energy of the sun penetrates to the permafrost soil layer, and through it also heat energy escapes into the atmosphere. In addition to the climate, other factors such as topography, vegetation, snow cover, and human activity have a great influence on temperature conditions. The differences in the thermal conditions of the various zones in the layer of frozen earth correspond to the diversity of local geographic conditions.

Hydrological conditions are very peculiar in the region of the distribution of permafrost. The distinguishing feature of this area is the presence of underground fossil ice, which is sometimes very thick. When it melts this underground ice adds to the supply of ground water, and fills up lakes, which are often formed in places where ice has melted. Ground water associated with permafrost is ususally divided into three classes: super-permafrost (nadmerzlotnyve), inter-permafrost (mezhmerzlotnyve), and sub-permafrost (podmerzlotnyve) (q.v.).

A peculiar phenomenon associated with seasonal freezing of the surface of the earth is the formation of ice-fields (naledi, q. v.). There are three types of these ice fields: surface (see cut), river, and underground.

Gigantic Ice Field in the Valley of the Tas-Khayakhtakh Mountain  ${\tt Range}$ 

Characteristic also are hilly formations whose interior consists of ice and icy earth, and which have been named hydrolaccoliths (gidroloakkolity, q.v.), "bulgunnyakhi", etc. Another widespread phenomenon in permafrost regions is solifluction, i.e., the flowing of over-moist porous earth; the flowing is complicated by the processes of freezing. A specific formation in this region is the thermokarst (termokarst, q.v.), the appearance of which is associated with sagging in the surface of the topography, the basic cause of which, in the absence of the usual karst (q.v.), is a thermic factor, specifically the thawing of the ice from the layer of frozen earth, resulting in the falling of certain sections of the surface of the earth.

The problem of the causes, conditions, and time of formation of permafrost is of great interest. The process of cooling of the earth's crust proceeds when in the course of a year it loses more heat than it receives, and when winter freezing is greater than summer thawing. The details of this process are still unclear in many respects. It is possible to assume that permafrost in some cases is of ancient origin, and that in others it is of contemporary or recent origin. The assertion that permafrost is of ancient origin conforms to a number of facts, such as the preservation of the undecomposed bodies of mammoths and other ex-

tinct animals, the thick strata of fossil ice deposited in the earth's crust along with the formation of ancient glaciers, etc. Arguments for the contemporary origin of permafrost are such facts as the recent formation of frozen earth in newly formed islands and river deposits, the discovery in permafrost earth of objects resulting from human habitation, and the preservation of undecomposed bodies of humans and horses, such as were found in Scythian graves in Altay, and whose interment dates from about 2,000 years ago. Depending on changes in the heat balance on the surface of the earth, changes are also produced in the heat conditions of the layers of permafrost earth, with variations sometimes toward colder conditions, and sometimes toward warmer.

The influence of human activity on conditions in the permafrost layers is said to be great. Deforestation, removing the undergrowth and moss cover from a region, and burning and fires disturb the temperature conditions of permafrost. Inhabitation of a locality also has its influence. This influence may be quite varied depending on the density of construction, changes in the conditions of snow cover, etc. The conditions of the permafrost may be distributed by various types of constructions which give off considerable quantities of heat. The disturbance of these conditions is especially great if the proper measures are not taken to remove the heat from the surface of the frozen earth. On the other hand the employment of existing cold and the adoption of a number of measures for improvement can make possible local control of permafrost, so that, if necessary, a thickening or, on the other hand, a local reduction of the permafrost layer is possible. Permafrost

often creates great difficulties for the construction and use of engineering installations, for agriculture, and other objects of socialist construction. (See Merzlotovedenive, Frost Control).

Map on page 604: Distribution of Permafrost in the Northern Hemisphere.

Map on page 605: Permafrost Regions in the USSR.

Legend: Regions and Ground Temperature, Generally at 10 - 15 Meters depth.

Below minus 5 degrees Centigrade (uninterrupted permafrost.

From Minus 5 to minus 1.5 degrees Centigrade (permafrost with Taliks).

Above minus 1.5 degrees Centigrade (with a preponderance of Taliks).

Around O degrees Centigrade (permafrost in patches).

Borders of permafrost regions and patches.

State frontiers of the USSR.

## BIBLIOGRAPHY

Obshcheye merzlotovedeniye (General Frost Control), Moscow-meningrad, 1940.

Sumgin, M. I., and Demchinskiy, B., Oblast' vechnoy merzloty (The Permafrost Region), Leningrad-Moscow, 1940.

Sumgin, M. I., <u>Vechanaya merzlota pochvy v predelakh SSSR</u> (Soil Permafrost within the USSR), Second edition, Moscow-Leningrad, 1937.

Tsytovich, N. A., and Sumgin, M. I., Osnovaniya mekhaniki merzlykh gruntov (Principles of the Mechanics of Frozen Earth), Moscow-Leningrad, 1937.

Tolstikhin, N. I., <u>Podzemnyye vody merzloy zony litosfery</u> (Underground Water of the Frozen Portion of the Lithosphere), Moscow-Leningrad, 1941.

Obruchev, V. A., "Uspekhi merzlotovedeniya v SSSR" (Successes of Frost Control in the USSR), in the book <u>Yubileynyy sbornik</u>, posvyashchennyy 30-letiyu Velikoy Oktyabr'skoy sotsialisticheskoy <u>revolyutsii</u> (Jubilee Symposium Dedicated to the Thirtieth Anniversary of the Great October Socialist Revolution), part 2, Moscow-Leningrad, 1947, (Academy of Sciences, USSR).

Ibid, "K 100-leiyu pervoy akademicheskoy ekspeditsii po izucheniyu \* vechnoy merzloty" (On the Hundredth Anniversary of the First Academic Expedition to Study Permafrost), Izvestiya Vsesoyusnogo geograf. ob-va, (Bulletin of the All-Union Geographical Society), 1946, Vol 78, nos 5 - 8.

Yanovskiy, V. K., "Vechnaya merzlota" (Permafrost), in the book <u>Sel'skokhozyaystvennaya entsiklopediya</u>, (Agricultural Encyclopedia), Vol 1, Moscow-Leningrad, 1937

Middendorf, A. F., <u>Puteshestviye na sever i vostok</u> <u>Sibiri</u> (Travels in the North and East of Siberia), Part 1, SPB, 1860.

Leffingwell, E., The Canning River Region, Northern Alaska, Washington, 1919 (United States Geological Survey, Professional Paper No 109).

Taber, St., "Perennially Frozen Ground in Alaska: Its
Origin and History", Bulletin of the Geological Society of America,
New York, 1943, Vol 54, No 10.

E N D